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Pressure-Wave Propagation Technique for Blockage Detection in Subsea Flowlines

Xianghui Chen, SPE,* Ying Tsang,** and Hong-Quan Zhang, University of Tulsa, and Tom X. Chen, SPE, Shell International E&P Inc.

* Now with Alion Science and Technology Corp.
** Now with Advanced Micro Devices

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Abstract

Solids blockage due to wax deposition and/or hydrate formation in subsea flowlines is one of the major risks for deepwater production systems. Blockage causes high pressure drop and even stop of oil and gas production. The ability to determine the location, length and severity of blockages allows operators to select cost-effective mitigation or remediation strategies and execute the corresponding mitigation or remediation procedures efficiently Due to the difficulty to access subsea flowlines, a remote technique to detect the blockages is highly desirable. This study investigated the feasibility of using the pressure-wave propagation technique to detect blockage in subsea flowlines.

Pressure waves are generated when the production stream is released for a very short period of time at the flowline outlet on the host facility (either a fixed platform or a floating platform). The pressure waves propagate through the flowlines at the local sonic speed and are reflected to the flowline outlet after encountering a blockage. The time and amplitude of the reflected pressure wave from the blockage are quantitatively related to the characteristics of the blockage. This transient method was examined numerically and experimentally in the present study. Results indicate that pressure-wave propagation technique is a remote, non-intrusive and cost efficient method that can be applied to detect blockages in gas transport pipelines and subsea wet gas multiphase flowlines with gas as the continuous phase.

Introduction

In previous literature, several methods and procedures for blockage detection purpose were proposed by different investigators. These methods can be basically classified as two categories: steady-state analysis and transient analysis. Frictional loss methods fall into the first category, while the methods that use transient pressure signature belong to the second category. Some of the methods combine these two techniques, e.g. the work by Liu and Scott [1].

As discussed by Chen *et al.*[2], frictional loss technique has been successfully applied in laboratory to provide an indication of diameter reduction due to paraffin deposition. However, this method can not detect localized partial blockages in the flowline.

The backpressure technique has long been recognized as an effective performance monitoring technique for gas wells. Scott and Satterwhite[3] applied this technique for blockage detection in gas lines by introducing the blockage factor. Scott and Yi[4] also used this method in liquid flowlines. The backpressure technique is a multi-rate test which establishes a pressure drop versus flow rate baseline curve. Deviations from this curve are indications of existence of blockages. The backpressure method only provides rough estimations because the effects of blockage length and size on frictional loss are coupled together. Because the baseline curve is dependent on the specific flowline, the backpressure method demands a great deal of experimental effort to establish the baseline curve, which significantly limits the method's application. Liu and Scott[1] extended the backpressure method to the average pressure method and tried to locate the partial blockage. This method requires three types of tests: steady-state back pressure test, which is identical to the backpressure method; simultaneous shut-in test to obtain the average pressure; and bleed-off test to determine the volume factor used in this method.

Pressure transient analysis has been utilized in well testing to characterize reservoir flowing properties including flow restrictions, such as reservoir permeability and skin effects, in the near wellbore region. Hasan *et al.*[5] attempted to apply this technique to locate and characterize flowline blockages. They examined the feasibility of using this technique by simulating drawdown test for a clean well and comparing its pressure response with that from the same well when it has developed a plug (partial blockage). They used additional frictional pressure drop to estimate the blockage severity and its length. Although blockage location can be a parameter in their simulation, Hasan *et al.* did not address how the location can be determined.